WHAT IS CLAIMED IS:

1. A semiconductor device comprising:

an insulating film having dielectric constant not greater than 2.7 and provided above a semiconductor substrate;

a via comprising a conductive material provided in a via hole formed in the insulating film;

a first interconnection comprising a conductive material provided in an interconnection trench formed on the via in the insulating film; and

a first high-density region formed in the insulating film, having a cylindrical shape surrounding the via hole, an inner surface common to a boundary of the via hole, and a film density higher than the insulating film.

2. The device according to claim 1, wherein the first high-density region has the film density greater than the insulating film.

3. The device according to claim 1, wherein the first high-density region has the maximum film density in a boundary between the via hole and the first high-density region.

4. The device according to claim 1, wherein a diameter of the first high-density region is smaller than a width of the interconnection trench.

5. The device according to claim 1, further comprising:

a second high-density region formed in the insulating film, and having a cylindrical shape surrounding the interconnection trench, an inner surface common to a boundary of the interconnection trench and a film density higher than the insulating film.

6. The device according to claim 5, wherein the second high-density region has the film density greater than the insulating film.

7. The device according to claim 5, wherein the first high-density region is thicker than the second high-density region.

8. The device according to claim 5, wherein the second high-density region is thicker than the first high-density region.

9. The device according to claim 5, wherein the thickness of the second high-density region is less than 25% of the minimum distance between second interconnections formed in the insulating film.

10. The device according to claim 5, wherein the insulating film includes:

a first insulating film provided at any height from a bottom end to a top end of the via hole; and

a second insulating film provided at any height from a bottom end to a top end of the interconnection trench.

11. The device according to claim 10, wherein the

second insulating film has a dielectric constant lower than the first insulating film, and a following relation is satisfied:

$$N_{ILD2} < N_{ILD1} = N_{via2} \leq N_{via1} \text{ or}$$
$$N_{ILD2} < N_{ILD1} < N_{via2} < N_{via1} \text{ or}$$
$$N_{ILD2} < N_{via2} < N_{ILD1} < N_{via1}$$

where,

N_{via1}: film density of the first high-density region

N_{via2}: film density of the first insulating film

N_{ILD1}: film density of the second high-density region

N_{ILD2}: film density of the second insulating film.

12. The device according to claim 10, wherein the first insulating film consists substantially of an organic polymer having a dielectric constant not greater than 2.3, and the second insulating film consists substantially of an organic polymer different from the first insulating film having a dielectric constant not greater than 2.7.

13. The device according to claim 1, wherein the insulating film consists substantially of an organic polymer having a dielectric constant not greater than 2.7.

14. The device according to claim 1, wherein the insulating film has a porosity not lower than 15% or film density not greater than 1.2g/cm^3.

15. A semiconductor device comprising:

an insulating film having dielectric constant not

greater than 2.7 and provided above a semiconductor substrate;

a via comprising a conductive material provided in a via hole formed in the insulating film;

a first interconnection comprising a conductive material provided in an interconnection trench formed on the via in the insulating film; and

a first high-concentration region formed in the insulating film, having a cylindrical shape surrounding the via hole, an inner surface common to a boundary of the via hole, and a carbon concentration higher than the insulating film.

16. The device according to claim 15, wherein the first high-concentration region has the carbon concentration greater than the insulating film.

17. The device according to claim 15, wherein the first high-concentration region has the maximum carbon concentration in a boundary between the via hole and the first high-concentration region.

18. The device according to claim 15, wherein a diameter of the first high-concentration region is smaller than a width of the interconnection trench.

19. The device according to claim 15, further comprising:

a second high-concentration region formed in the insulating film, and having a cylindrical shape surrounding the interconnection trench, an inner

surface common to a boundary of the interconnection trench and a carbon concentration higher than the insulating film.

20. The device according to claim 19, wherein the second high-concentration region has the carbon concentration greater than the insulating film.

21. The device according to claim 19, wherein the first high-concentration region is thicker than the second high-concentration region.

22. The device according to claim 19, wherein the second high-concentration region is thicker than the first high-concentration region.

23. The device according to claim 19, wherein the thickness of the second high-concentration region is less than 25% of the minimum distance between second interconnections formed in the insulating film.

24. The device according to claim 19, wherein the insulating film includes:

a first insulating film provided at any height from a bottom end to a top end of the via hole; and

a second insulating film provided at any height from a bottom end to a top end of the interconnection trench.

25. The device according to claim 24, wherein the second insulating film has a dielectric constant lower than the first insulating film, and a following relation is satisfied:

$N_{ILD2} < N_{ILD1} = N_{via2} \leq N_{via1}$ or

$N_{ILD2} < N_{ILD1} < N_{via2} < N_{via1}$ or

$N_{ILD2} < N_{via2} < N_{ILD1} < N_{via1}$

where,

N_{via1}: carbon concentration of the first high-concentration region

N_{via2}: carbon concentration of the first insulating film

N_{ILD1}: carbon concentration of the second high-concentration region

N_{ILD2}: carbon concentration of the second insulating film.

26. The device according to claim 24, wherein the first insulating film consists substantially of an organic polymer having a dielectric constant not greater than 2.3, and the second insulating film consists substantially of an organic polymer different from the first insulating film having a dielectric constant not greater than 2.7.

27. The device according to claim 15, wherein the insulating film consists substantially of an organic polymer having a dielectric constant not greater than 2.7.

28. The device according to claim 15, wherein the insulating film has a porosity not lower than 15% or film density not greater than $1.2 g/cm^3$.

29. A method of manufacturing a semiconductor

device, comprising:

forming an insulating film above a semiconductor substrate, the insulating film having dielectric constant not greater than 2.7 and having a via hole;

forming a buried insulating film on the insulating film while filling the via hole;

forming an interconnection trench connected with the via hole in the buried insulating film and the insulating film;

removing the buried insulating film; and

filling the via hole and the interconnection trench with a conductive material.

30. The method according to claim 29, wherein forming an insulating film having dielectric constant not greater than 2.7 and having a via hole includes:

forming the insulating film above the semiconductor substrate; and

forming the via hole in the insulating film by etching.

31. The method according to claim 29, wherein removing the buried insulating film is carried out using wet etching.

32. The method according to claim 31, wherein the buried insulating film consists substantially of a material selected from a group consisting of a material same as the insulating film, a material same as the insulating film and having a film density higher than

the insulating film, and SiO_2.

33. The method according to claim 29, wherein forming an insulating film having dielectric constant not greater than 2.7 and having a via hole includes:

forming a first insulating film above the semiconductor substrate;

forming a second insulating film different from the first insulating film on the first insulating film;

forming the via hole in the first insulating film by etching; and

forming the interconnection trench connected with the via hole in the second insulating film

34. The method according to claim 33, wherein the buried insulating film consists substantially of a material selected from a group consisting of a material same as the first insulating film, a material same as the first insulating film and having a film density higher than the first insulating film, a material same as the second insulating film, a material same as the second insulating film and having a film density higher than the second insulating film, and SiO_2.

35. A method of manufacturing a semiconductor device, comprising:

forming a first insulating film above a semiconductor substrate, the insulating film having dielectric constant not greater than 2.7 and having a via hole;

forming a second insulating film different from the first insulating film on the first insulating film while filling the via hole, the second insulating film having dielectric constant not greater than 2.7;

forming an interconnection trench connected with the via hole in the second insulating film while removing the second insulating film in the via hole; and

filling the via hole and the interconnection trench with a conductive material.

36. The method according to claim 35, wherein the first insulating film consists substantially of an organic polymer.

37. The method according to claim 35, wherein the second insulating film consists substantially of an organic polymer different from the first insulating film.